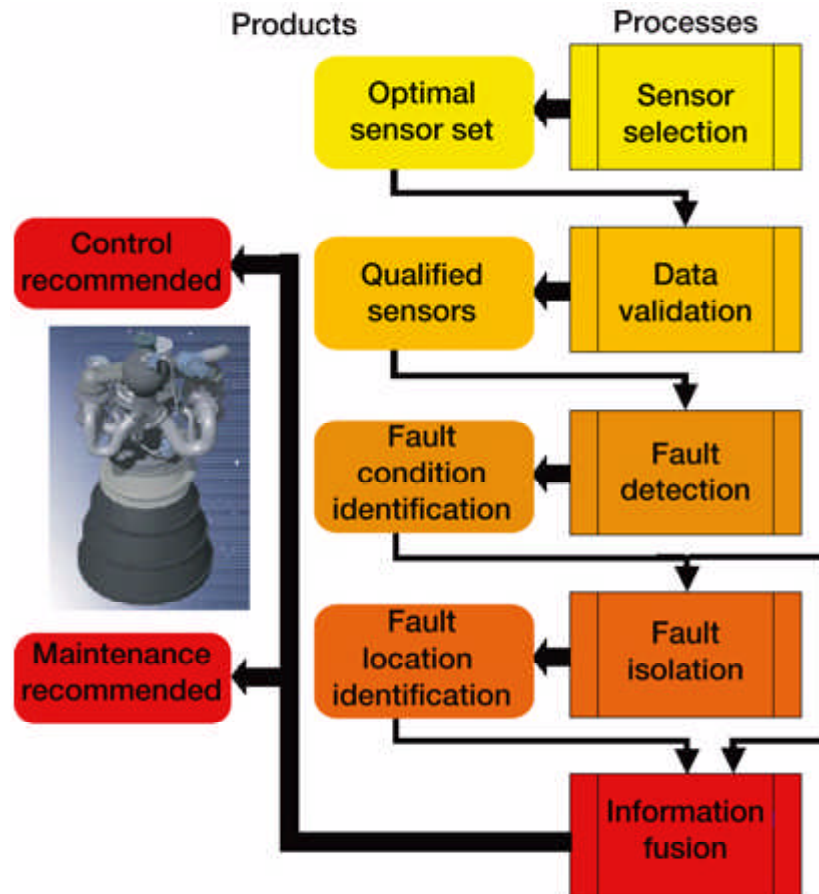


Strategy Developed for Selecting Optimal Sensors for Monitoring Engine Health

Sensor indications during rocket engine operation are the primary means of assessing engine performance and health. Effective selection and location of sensors in the operating engine environment enables accurate real-time condition monitoring and rapid engine controller response to mitigate critical fault conditions. These capabilities are crucial to ensure crew safety and mission success. Effective sensor selection also facilitates postflight condition assessment, which contributes to efficient engine maintenance and reduced operating costs. Under the Next Generation Launch Technology program, the NASA Glenn Research Center, in partnership with Rocketdyne Propulsion and Power, has developed a model-based procedure for systematically selecting an optimal sensor suite for assessing rocket engine system health. This optimization process is termed the systematic sensor selection strategy.

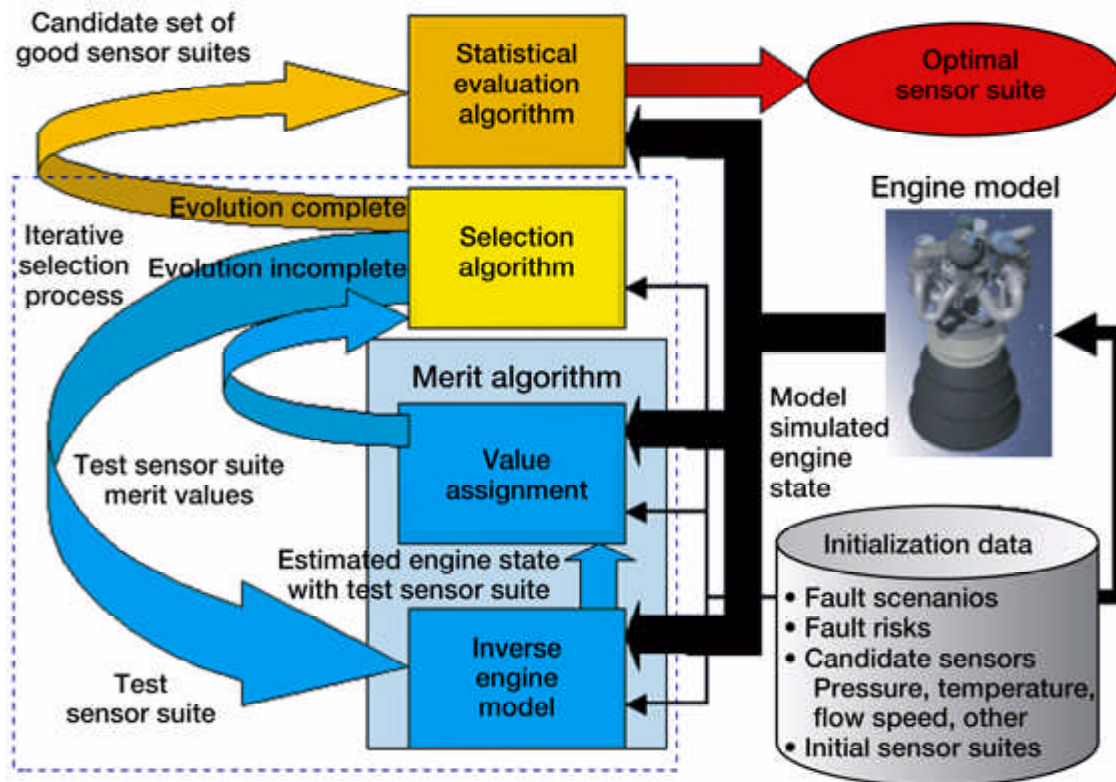


Sensor selection enables diagnostics for engine health management.

Engine health management (EHM) systems generally employ multiple diagnostic procedures including data validation, anomaly detection, fault-isolation, and information fusion. The effectiveness of each diagnostic component is affected by the quality,

availability, and compatibility of sensor data. Therefore systematic sensor selection is an enabling technology for EHM.

Information in three categories is required by the systematic sensor selection strategy. The first category consists of targeted engine fault information; including the description and estimated risk-reduction factor for each identified fault. Risk-reduction factors are used to define and rank the potential merit of timely fault diagnoses. The second category is composed of candidate sensor information; including type, location, and estimated variance in normal operation. The final category includes the definition of fault scenarios characteristic of each targeted engine fault. These scenarios are defined in terms of engine model hardware parameters. Values of these parameters define engine simulations that generate expected sensor values for targeted fault scenarios. Taken together, this information provides an efficient condensation of the engineering experience and engine flow physics needed for sensor selection.



Systematic sensor selection strategy.

The systematic sensor selection strategy is composed of three primary algorithms. The core of the selection process is a genetic algorithm that iteratively improves a defined quality measure of selected sensor suites. A merit algorithm is employed to compute the quality measure for each test sensor suite presented by the selection process. The quality measure is based on the fidelity of fault detection and the level of fault source discrimination provided by the test sensor suite. An inverse engine model, whose function is to derive hardware performance parameters from sensor data, is an integral part of the merit algorithm. The final component is a statistical evaluation algorithm that characterizes

the impact of interference effects, such as control-induced sensor variation and sensor noise, on the probability of fault detection and isolation for optimal and near-optimal sensor suites.